Gas Attack---The Unused Weapon of World War II

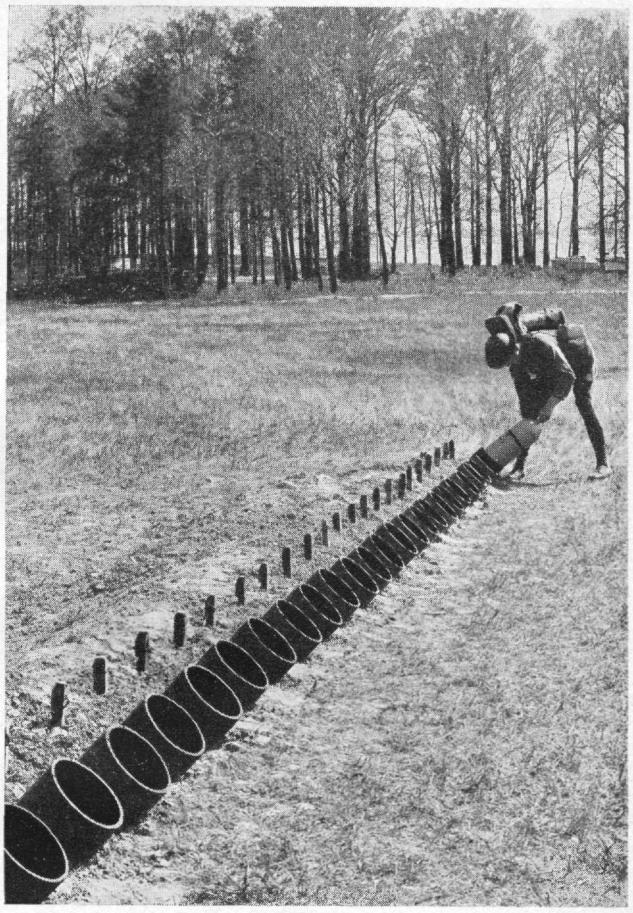
By Lewis Hullinger, Ch.E.II

In the wars between the Athenians and the Spartans from 431-404 B.C. a new method of forcing an opponent into submission was introduced. This was gas warfare, the recent development of which has made it perhaps the most fearful tool of aggression yet devised by man. Between its introduction into warfare and its development during the World War, however, little use was made of the substance. The early uses of gas were crude, and the ignition of such materials as pitch, sulfur, and resin was the chief application.

Though the French had used brominated esters in hand grenades as early as 1914, the first large-scale use of poison gases was made by the Germans in the rout of Ypres on April 22, 1915. The French were completely surprised by the attack, and the number of casualties was enormous. On April 26, 1915, gas was liberated against two French battalions which were making a lone assault. Had the German high command realized the significance of the effect of gas, the war would undoubtedly have ended differently. The failure of the Germans to follow up this victory enabled the Allies to devise counter-measures against gas attack.

The gases used in warfare are divided into four groups. The first group, the lacrimators, or tear gases, is effective in extremely low concentrations, producing a heavy flow of tears upon coming into contact with the eye tissues. Their physiological effects on the individual are immediate, but they possess no toxic effect. The second group, the lung injurants, on the other hand, has a highly toxic effect on the system, affecting the lungs, and causing a chemical type of pneumonia. A typical gas of this group is phosgene. A third group, the vesicants, or blistering agents, has a highly decapacitating effect on the individual. The wounds inflicted by these gases take a long time to heal, and careful hospitalization is necessary. The characteristic gas of this group is mustard gas. The final group, the sternutators, or vomiting gases, is effective in low concentration, and their action is immediate. They attack the nervous system, producing violent nausea and headache, depending on the amount inhaled. Their effects may be toxic, but usually last about two hours, with more serious cases lasting up to twenty-four hours.

The effectiveness of a war gas is determined by three types of properties. The first of these is that which indicates its effect on the body. A minimum concentration which provokes a painful sensation is



Courtesy News Edition, Industrial and Engineering Chemistry.

Livens Projector Preparing to Start Gas Attack

desirable. Another favorable property is a low limit of insupportability. The limit of insupportability is the maximum concentration which a normal man can withstand without injury for a certain period of time. Thus, those gases with a low limit of insupportability will be more quick-acting. A third property of this group is the mortality product, or lethal index. This expression is given as the product of the concentration, c, of the substance in air (ma./cu.m) by the duration, t, of its action (in minutes) sufficient to cause death.

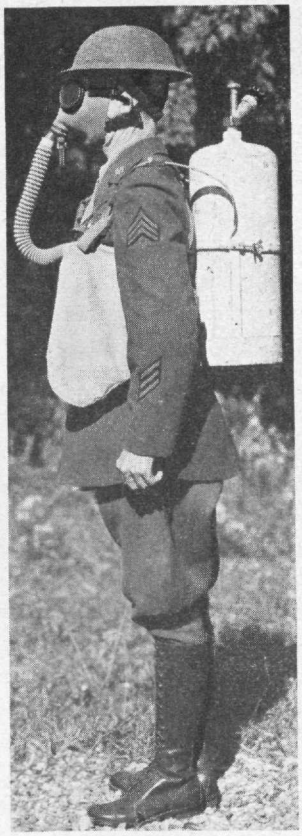
A second type of property studied in the selection of a suitable gas is the physical property. The gas, when released, is usually in the form of a liquid. A high vapor pressure in the liquid indicates a high volatility, which is necessary to produce an effective concentration of gas. Liquids to be used in cold areas

must have a low freezing temperature. Chlorobenzene or carbon tetrachloride is often added to lower this point. Another property is the persistence of the gas, or the time during which the gas will continue to act effectively in an open space. Conditions which influence this property are speed of evaporation, temperature of the air, physical nature of the ground, and the density of the substance.

The third type of property to be considered is the chemical property. The gas must be inactive to water and air. It must not decompose during storage. It must be stable to explosion, and able to resist the heat evolved in the setting off of the charge in the projectile. It must have no chemical effect on the container. Corrosive action often necessitates the use of supplementary containers which resist the action of the substance, such as glass.

Various methods have been used to project gases against the enemy. The first attack made use of cylinders, which were hauled to the trenches with long hose attachments. Due to its ease of detection and the fact that it could be used only for chlorine, it was for the most part discarded. Two British inventions, the Livens projector and the Stokes mortar, came into use later, and accomplished their purpose by shooting projectiles. On exploding, the pressure was released from the liquid in the container, and it evaporated into the air. The same principle lies behind the use of hand grenades. Highly volatile liquids could not be used in these devices, because the projectiles could not be shot at a rapid enough pace to keep the concentration high. For this reason, the more volatile gases were shot in the projectiles from the larger guns.

Another method of dispersion is by means of airplanes. This is accomplished by one of three methods. In one of these, termed sprinkling, the liquid is forced from the plane under a pressure of carbon dioxide which gives it a jet velocity nearly equal to the velocity of the plane. The effect is that of releasing the chemical in still air and it falls to the ground in drops like rain. A similar method, "spraying", does not use pressure, the liquid breaking up into a fine mist on colliding with the air. A third means of dispersion is by dropping gas "bombs", whose contents evaporate with the burst of the container. Sprayed gases lose much of their concentrations before reaching the ground, and so are seldom



Sergeant of the United States Army Equipped with the latest type gas mask. Canister is in pack on left front. Tank strapped on his back.

Courtesy News Edition, Industrial and Engineering Chemistry.

Troops firing gas shell in mortar.

Courtesy News Edition, Industrial and Engineering Chemistry.

effective aside from frightening their intended victims. Gas attack with bombs likewise has its problems, due to the difficulty in releasing enough bombs to set up a lethal concentration. Nevertheless, due to their wide range and movability, airplanes and artillery guns afford the best means of dispersing gases.

Many factors must be taken into consideration in the tactical use of gas. The persistent gases should not be fired on a possible objective. They should be fired in such a manner as to effect the greatest number of infected areas. Non-persistent gases should be fired only on occupied positions. The wind, humidity, weather, and terrain also must be considered.

Protection, both of civilian population and of troops, has created a serious problem for military leaders. Protection is accomplished either by means of gas-proof shelters, or by individual protection with gas masks and protective clothing. Air for the shelters is drawn from a source 30 feet above the ground and toxic particles removed in a filtration plant. Fans are used for ventilating purposes, and air-conditioning units prevent excessive heat and humidity which may be generated in such close quarters. Gas masks are made of rubber, with eye-pieces of celluloid or special types of glass. The outlet valve, usually made of rubber, must be leak-proof. Respirators contain activated carbon, because of its high absorptive power, and special chemicals which remove vapors unaffected by carbon. The best filters will remove 99% of the toxic vapors from the air breathed. Clothing for protection against such chemicals as mustard gas has been made of such materials as oilskin and cloth impregnated with a chlorinating agent, but has proved uncomfortable for sustained wear.

Decontamination is also essential in the protection of communities. This is the procedure by which chemical agents are either washed away or smothered with dirt. A mixture of bleaching powder with three times its bulk of sand or earth is an effective decontaminating agent. Clothing may be decontaminated by exposure to the air, washing, and solvents.

Though many deaths have resulted from the action of gases, their effectiveness lies in their disabling power. For one thing four men are required to attend each hospital case. Further, the use of gas forces the enemy to don protective clothing, which hampers their efficient operation. The apparent absence of gas from the present war is strange, considering its effectiveness in the World War. Nevertheless, the careful training being given to civilian populations indicates that its use in the future would not be surprising.

EDITOR'S NOTE:

From comments by persons, both in and out of the military services, it is evident that the real value of war gases lie in its inciting of fear and breaking of morale. Informed sources further contradict feature stories of enormous damage to be inflicted by new gases just developed. Any recently developed gases are very few and are well known to all military authorities.

Courtesy Ohio State University Monthly

Old Ohio Field where early Buckeyes battled for gridiron honors. Armory in the background shows this to be in the Northeast corner of the present campus. Notice seating method on near side of field.